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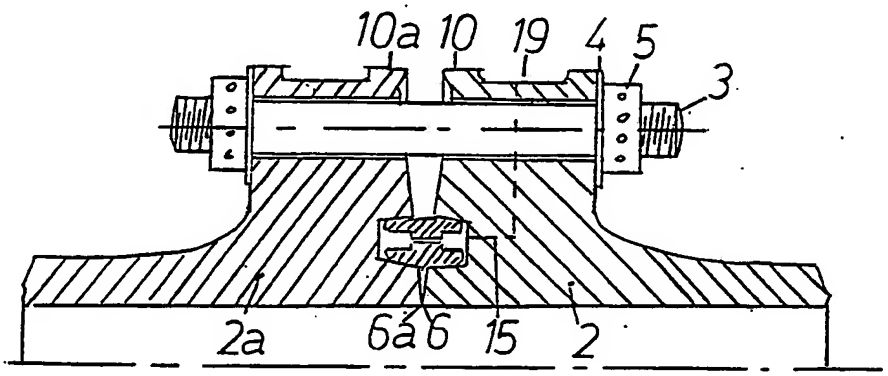

(57) Abstract

Flange for pipe joints with pipes leading fluids under high pressure, where the flange comprises a contact surface (6, 7; 6a, 7a) which, when the securing bolts (3) for the pipe joints are not tightened, form an outwards directed angle to each other, and being forced towards each other when the securing bolts (3) are tightened. The flanges may also comprise outer and inner depending sections (8, 9; 10, 11) for further tightening effect, and may additionally possibly comprise washer/gasket grooves (12) and washers/gaskets (20).

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Coupling for flanged pipes, process for connecting the flanges and use of the coupling.

The present invention concerns compact flanges for pipe connections for pipes carrying fluids under high pressure and/or being subject to large mechanical forces. Such flanges for pipe connections are used within offshore/sub-sea, process and/or landbased indurty and nuclear power plants, and especially for riser pipes and tension stays in the oil industry. A flange is in this connection each half of a pipe connection or a coupling. The words "connection half" or "flange" are often used alternately, but a coupling of such halves, said halves most often being similar but may be different, makes a pipe connection, and close-fitting pipe connections is the object of the present invention.

Within this area there are several types of known technique for connective methods and devices for such connections of pipelines. The commonly known flanges/connections/clamps are sold under the names API-flanges, API clamps/hub, and they may also comprise threaded connections or couplings. Common for these connections and methods is that they are based on e.g. flat or "raised face" flange surfaces with surface gaskets, compact ring-groove washers or inwardly conical tightening elements.

An example of such a known flange type is disclosed in GB patent 1.559.388 where there is shown a flat flange surface with a connection of the flange parts with conventional nuts.

When connecting the flange parts there will also arise tensions in the flange material in the parts connecting the horizontal and the vertical flange parts. To distribute and relieve such material tensions it is known to give the transitional area between each flange part an elliptical shape. It is thus known from US patent 4.183.562 to give the surface the shape of a quarter of an ellipse in such an

area, the larger axis of the ellipse being parallell with the pipe and this larger axis being about two times the length of its smaller axis. However, the tensions in the material in such a flange depends on the load points of the flange surface and on the tension forces in the pipe connection, so that this form of an elliptical transition is only advantageous for conventionally formed flange types of the kind mentioned above.

A disadvantage in the existing flange connections is that there will often arise leaks after a time as a consequence of varying loads and high tensions combined with thermal strains and vibrations. In connection with this it is often necessary to perform mechanical maintainance such as e.g. to post-tighten blots and change washers.

Another disadvantage with these types of pipe connections is that they are characterized by large dimensions and high weight.

A third disadvantage is that the existing couplings have non-resilient tightening elements and simultaneously that the elements of the coupling move relative to each other during load variation, which contributes to leaks and other time-accumulating damage on the connection.

A fourth disadvantage is that the known types of flanges may not without special measurments be tested for leaks in a simple way during/after their installation.

A fifth disadvantage from a corrosive point of view is that existing couplings have "wet" bolts, i.e. bolts being subjected to e.g. sea water will develop rust damages after having been mounted in the flange parts.

As an example none of the mentioned flange types disclosed in GB patent 1.559.388 or US patent 4.183.562 will avoid such damage or be exempted from these disadvantages.

As there are discovered oil finds within the offshore industry on successively larger depths, the use of riser couplings and sub-sea couplings will be of increasingsly greater importance. In this connection the use of compact couplings with low weight, small physical dimensions and minimal maintainance will also get an increased significance, and this represents the basis of the present invention.

A purpose of the present invention is thus to provide a flange or a pipe connection avoiding the above indicated disadvantages with varying loads, high tensions, high pressure etc, simultanously making testing for pressure tightness very simple and exact during mounting "in situ" and during performance under full pressure in the pipeline.

In the following the present invention will be disclosed with reference to the attached drawings wherein:

Fig. 1 shows two pipes connected with a coupling of flanges of the relevant type.

Fig. 2 shows a flange according to Fig. 1 as seen from A.

Fig. 3 shows a section through B-B according to Fig. 2 before tightening of the bolts.

Fig. 4 shows a section through a flange in a basic design.

Fig. 5 shows a section through a flange with three conical surfaces and an outer depressed section on the outer diameter.

Fig. 6 shows a section through a flange with one conical surface, tightening groove and a bore for a test port.

Fig. 7 shows a section through a flange with two conical

surfaces, tightening groove and a threaded hole for pin screws.

Fig. 8 shows a section through a pipe connection with one plane flange, one flange with a conical surface, tightening washer and bore for test port before tightening of the bolts.

Fig. 9 shows a section through a compact flange coupling according to the present invention in a free condition before tightening of the bolts, and where each of the flanges are equipped with two conical surfaces, tightening grooves with a tightening washer, bore for test port in one of the flanges, depressed outer section on the outer diameter and tightening pin screws with base washers and nuts.

Fig. 10 shows a section through a flange coupling according to the present invention where there is present an alternate opening direction between the flanges.

Fig. 11(a-d) shows a particular flange design according to the invention.

With reference to Fig. 1 the flange assembley, in order that the flanges according to the invention may function properly, should to be built into a pipeline or pipe structure 1, 1a with two flange halves 2 and 2a, connection bolts 3 with base washers 4,4a and nuts 5,5a. The flanges 2,2a need not necessarily be identical, but may have any individual structure according to Figs. 4, 5, 6, 7 and 8. The stucture of each flange is, however, not limited to these embodiments, but are designed as indicated in the attached claims.

According to the invention the coupling, to act according to its intension, exhibits the following separate features:

- At least one of the two opposite flange surfaces 6,7;6a,7a is designed such that it or they is/are conically shaped (Figs. 3 and 4).

- Each of the two opposite flanges is designed such that the opposite surfaces 6,7;6a,7a (Figs. 3 and 4) are conical.

- Each of the two opposite flanges are designed such that the surfaces 6,7;6a,7a (Figs. 3, 4, 8 and 9) in a radial section form an angle with each other in such a way that the distance between the two opposite surfaces increases with increasing radius in an assembled connection before the bolts 3 are tightened. A preferred angle of inclination of the surfaces 6, 7 relative to a flat imaginary plane constitutes 0,2-3,0°, preferably 0,2-0,5°, but greater and smaller angles may also be used, inter alia depending on material and tolerances in the pipe joint and the flange halves. Two opposite coupling halves are according to the invention designed such that the two adjacent surfaces have an ouwardly directed increasing distance to each other. The greatest angle depends on whether the bolts 3 may be tightened so that the flange planes meet each other (see disclosure below).

- When joining the flanges 2, 2a with the bolts 3, the flange surfaces 6, 7 and/or 6a, 7a will rotate under the correcting forces, preferably to abutment with each other, so that the conical slot between the surfaces 6, 7 and 6a, 7a become closed.

Instead of bolts e.g. clamp connections or other conventional connecting devices may be used, and the outer part's rear flange surface is simultaneously given a shape suited for this purpose.

- The angle between the surfaces 6, 7 and 6a, 7a is further preferably designed such that 50-100% of the prestressing force of the bolts is necessary to close the conical slot

which is produced by this angle. It is preferred that the compression force by closing the slot is about 70-80% of the bolts' prestressing force. Such a force is of course dependent on and relative to e.g. the kind of material used in the flange.

The opening angle α between two opposing flanges is material-dependent. It is inter alia dependent on the yield point of the flange material, $\sigma\gamma$, and elasticity modulus, E, in such a way that $\alpha \approx K(\sigma\gamma/E)$, where K is a constant which is characteristic for the total geometry of the coupling and which may vary from one design of the coupling to the other. Determination of K is within the competence of the person skilled in the art. The diameter and the wall thickness of the pipe and the number, diameter, solidity class of the bolts are among the parameters contributing to the variation of K.

- The prestressed length of the bolts 3 is preferably at least 3 times their diameter, and preferably 6 to 8 times the diameter of the bolts.

A further feature of the design of the flange according to the invention is to equip the outer and/or inner edges 6, 7; 6a, 7a with a wedge-shaped projection 6, 8,9; 7, 10, 11 (Fig. 5). By providing the flange with conical areas 6, 8, 9; 7, 10, 11, the conical surface 10, 11; 8, 9 has a conicity which is different from the conicity of the flange surface 6, 7. By such a design there is achieved a further tightening in the flange when tightneing the tension bolts 3. The projecting areas 8, 9; 10, 11 may extend for an indefinite distance from the outer edge 7 and the inner edge 6 of the flange respectively, over the inclined area 6, 7, but extend preferably no farther in from the outer/inner edges than that the ratio between the inclined flange section and the projection(s) is 2:1 or larger. The length of the projecting areas 8, 9; 10, 11 is independent of each other, but will each normally be less than 1/4 of the

distance between the two main surfaces 6, 7; 6a, 7a in the outer edge of the joint.

To produce a further tightening in the flange-joint it is preferred that the flange is equipped with a groove 12 for a washer/gasket. Such a washer/gasket may be of a conventional type, but it is preferred that it is of a flexible type of the design specified in Norwegian patent application No. 90.2332, and which is included herein per reference. The washer/gasket is, however, not limited to such a geometrical design, but represents only a preferred embodiment.

Concerning the washer groove 12, this has preferably side surfaces 13, 14 (Fig. 6) forming an angle of ± 10-20° with a central line extending parallell with the longitudinal axis of the flange. A condition is, however, that the outer surfaces 20, 21 (Fig. 8) of the washer/gasket are at least partially aligned with the side surfaces 13, 14 of the groove 12. Tolerances for such adjustments will be known by the person skilled in the art.

An alternative embodiment of the design of the flange according to the invention will be to equip the flange with a bore 15 (Fig. 6) joining the threaded connection on the outer surface to the bottom of the washer groove 12. By such an alternative design it will be possible to pressure test each joint for tightness and pressure resistance without adding an inner pressure to the pipe. (See also Norwegian patent application no. 90.2332.)

As previously mentioned, it is preferred that the intermediate area 16, 18 between the part of the flange extending mainly parallell 16, 23 to the length axis A of the pipe 1, 1a, and the part of the flange extending mainly perpendicular 18, 22 to the length axsis A of the pipe (Fig. 4) has an elliptical shape to achieve the lowest possible tension concentration factor in connection with this cross-

secitonal transitional area. Such an elliptical transitional area 16, 18 begins at the outer surface 16 of the flange and is tangential to the rear flange plane 18, 22 (Fig. 4) of the flange. When designing the tightening plane of the flange, as disclosed above, the elliptical form will, however, optimalize the tension distribution in the flange material at a ratio between the large and small axes of the ellipse within the ratio interval 3:1 to 5:1, preferably 4:1, so that the ability of the connection to resist mechanical loads is optimalized.

The flange is also alternatively designed with a depressed section 19 (Fig. 5) on the outer axis-symmetrical flange surface. The purpose of such a depressed section 19 is primarily to provide a possibility for the material between the depressed section 19 and the plane 10, 11 to act as a resilient section to improve the tightening action at the projecting part 10, 11 when bringing the joint parts together, and secondarily to be able to reduce the amount of material used for the coupling halves, which results in a reduced weight. The depth of the groove 19 is related to the flange material, and it should preferably be deeper than the depth of the projecting section 10, 11, as an example 2 to 3 times the depth of the projecting section 10, 11.

Each flange of the pipe joint according to the invention may individually comprise at least one of the above indicated features, each of the features providing an improved tightening safety and/or ability to withstand mechanical stress compared to the type of flanges known. However, it is advantageous to combine two or more of the above indicated features to provide optimal properties in the flange joint according to the invention. The features which are preferably to be combined are:

- That the flanges have conical opposing surfaces 6, 7 prior to pretensioning the bolts 3;
- That the distance between the opposing surfaces increase

with increasing radius towards the outer surface of the flange;

- That the flange planes 6, 7 rotate to tightening against each other when joining the flanges;
- That the angle beween the opposing surfaces 6, 7 is designed so that 50-100% of the pretension force of the bolts 3 is necessary to close the slot between the conical surfaces 6, 7; 6a, 7a;
- That the bolt(s) is/are equipped with suitable caps preventing an external medium to penetrate into the joint along the bolts.

Further, in addition it is preferred that the flange(s) according to the invention is/are provided with the following alternative features:

- That the pretension length of the bolts 3 is at least 3 times the diameter of the bolts;
- That there on one or both of the outer edges of the flanges are located wedge-like protruding sections 8, 9; 10, 11;
- That the flange is equipped with a washer groove 12, preferably at an angle of between ± 10 and 200 to a centre line parallell to the longitudinal axis of the flange, but other types of grooves may also be of interest, e.g. grooves for an O-ring;
- That the flange(s) have an elliptical intermediate section 16-18 so that the ratio between the large and the small axsis of the ellipse lies in the interval 3:1 to 5:1, preferably 4:1.

As a further preferred design of the flange according to the invention there may be included:

- That the conical plane of the protruding section(s) 8, 9; 10, 11 have a conicity which differs from the one of the flange surface 6, 7;
- That the flange(s) is/are provided with a bore 15

joining a threaded connection on the outer surface and the bottom of the tightening groove;

- That the flange(s) is/are equipped with a depressed section 19 on the outer axis-symmetrical flange surface.

The advantages achieved by designing the flange(s) according to the features mentioned above, will consist in that there is provided a high contact pressure at the flange surfaces 6, 7; 6, 10; 8, 7; 8, 10 and corresponding surfaces in the opposing flange 2a for a completely tight joint, resulting in that the shafts of the bolts 3, and also the tighteing washer, by using a tightening device, normally will not be exposed neither to external medium nor to internal medium in the pipeline 1, 1a. Additionally, a thightening washer in the washer groove 12 and in the corresponding washer groove in flange 2a (Fig. 9) will likewise provide complete tightness in the flange joint, even if tightening at a high contact pressure 6, 6a (Fig. 9) should be broken. When the bolts 3 are correctly prestressed and the conical slot between the flanges 2,2a is closed, the bolt tension will be nearly static, with very small additional tension stresses resulting from varying mechanical and/or thermal loads in the joint, and as a consequence the danger of fatigue in the bolts/joint elements 3 will be as good as eliminated.

By providing the flange(s) with conical surface(s) forming an angle which each other and with a connection such that the surfaces are pressed towards each other, it will be an advantage to provide the outer surfaces of the flange(s) with an elliptical intermediate section between the parts which extend parallell 16, 23 and perpendicular 18, 22, respectively, to the longitudinal axis A of the pipe 1, 1a. Thereby, the flange may be given a small flange diameter in relation to the pipe diameter as compared to conventional pipe connections, and thus small flange dimensions and low weight are achieved. Additionally, this results in low and advantageous tension forces in the hollow wedge 16-18 (Fig. 4) so that fatigue is avoided. By combining an elliptical

design with a depressed outer groove 19, the flange assembly may additionally be given a further reduced weight.

As a consequence of the above indicated features and advantages, a pipe joint with flanges according to the invention will also be very environmentally safe since tightness and a large degree of safety against fatigue in bolts or other mechanical destruction of the mechanically maintainance-free connection during operation will be ensured at any time.

As a consequence of the feature that at least one of the flanges of the pipe joint may be provided with a bore 15 for access to the groove 12, surveillance/drainage of a possible leakage past the inner flange edge 6, 6a, 9 may be performed, which may be of interest when exeptionally strict demands to safety are present. Additionally, an embodiment of the pipe joint as shown in Figs. 8 and 9, where a resilient washer ring is present, may provide for the connection to tolerate overload/separation without leakage occurring.

The flange assembly according to the present invention is mechanically maintainance-free since setting/destruction of non-metallic washers/gaskets or other elements is eliminated by there being no relative movement between the elements of the flange assembly by the influence of pressure and loads on the joint. The mechanical strength of the flange assembly may to a large degree of reliability be evaluated from tensional estimations and material data, since the internally static behaviour of the joint during operation ensures that the load response remains unchanged during the entire operational time. As a consequence of the above mentioned properties, results from static tests with e.g recordings of tension loads may be transformed to lifetime conditions with respect to fatigue.

Pipe connections with flanges designed according to the

present invention may advantageously be used as flange assemblies in riser pipes extending from a well head to production platforms, in riser pipes i under-water modules, for flange assemblies of stretch stays for stretch stay platforms, within both offshore, onshore, and land based process industry, as well as in nuclear power plants.

A preferred embodiment of a flange joint made of steel comprising flange halves according to the invention, will be where the conical area 6, 7 has an angle of 0,3°, where the flange joint is provided both with inner and outer protruding sections 8, 9; 10, 11 where the protruding length of both sections are equal, and which length corresponds to 20% of the diference in height between the lower and the upper conical sections 6, 7. The protruding parts advance into the conical section over a distance which is half the distance from the outer edge 10 of the connection to the hole for the bolt. Further, such a preferred embodiment comprises a groove 12 for a washer, preferably of the type disclosed in Norwegian patent application No. 92.2332, as well as an elliptical transitional section between that part of the flange which extends mainly parallell 16, 23 to the longitudinal axsis A of the pipe 1, 1a and that part which extends mainly perpendicular 18, 22 to the longitudinal axis A of the pipe 1, 1a, the relation between the large and the small axis of the ellipse being 4:1. The groove 12 for the washer is preferably located so that the distance from the inner surface of the flange to the closest edge of the groove is 1/4 of the thickness of the pipe wall 1, 1a. The washer groove is, however, not placed so close to the inner surface that it influences on the inner depending edge 8, 9. Besides, the dimensioning of this washer groove is of a workman-like character. The circumferential depressed groove 19 providing resilience to the outer depending section 10, 11 of the flange half is located with its center so that the point where the plane defined by the inclined flange surface 6, 7 intersects the outer surface 7 of the flange lies at a smaller or an equal distance from the

groove 19 than the distance beween the outer section 18, 22 of the flange extending perpendicular to the axis A of the pipe and the other section of the groove. The width of the groove 19 extends across 2/3 of the outer surface 10, 22; 7, 22 of the flange half, and the depth of the groove 19 is larger than the depth of the outer depending edge 10, 11, preferably twice this depth.

Legend to fig. 11 a-d:

In fig. 11 a-d there is shown a preferred embodiment of a flange according to the invention. The figures refer to a flange with a total outer diameter $Ø_1$ of 172,6±0,1 mm, diameter $Ø_2$ between the center line for opposit holes for securing bolts 3 of 144,6 mm, diameter $Ø_3$ for the bolts' 3 securing holes of 15,0±0,1 mm, diameter $Ø_4$, $Ø_5$ between opposit edges of the groove for the washer (inconel 625) located in the groove 20,21 is for outer and inner measurements 121,95±0,1 mm and 84,2±0,1 mm, respecitvely. The diameter $Ø_6$ for the center line of the groove 20,21 for the washer (inconel 625) and the inner and outer edges of the groove is in this embodiment 15±0,05°. The inner measurements of the washer groove I is in this embodiment 18,87 ±0,05 mm. Fig 11a shows an overview of a section of an embodiment of a flange according to the invention, while fig. 11b shows the circled detail B in fig. 11a. Fig. 11c shows a section of the flange seen from above with indicated holes for securing bolts 3. In fig. 11c an angle δ between the holes for the securing bolts of 22,5±0,05° is given. In fig. 11a the height H_1 of the flange is 103,9±0,2 mm and the height H_2 between the horizontally protruding parts and the upper part of the inclined section of the flange plane is 48,3±0,1 mm. The inclined upper part of the flange has an angle ϵ to the horizontal plane of 37,5±2,5°. Detail B from fig. 11a, shown in fig. 11d, has the following measurements: The distance A_1 of the pendant outer edge of the flange from its outer edge to the joint plane is 3,0±0,1 mm, the distance A_2 between the outer edge of the flange to the downmost point of the pandant part is 0,5±0,1 mm with an inclination angle 45° and the height A_3 of the pendant part is 0,023±0,005 mm.

The above specified measurements concern a special embodiment of the flange according to the invention and other measurements and sizes may be used within the scope of the attatched claims.

C l a i m s

1. Coupling (2, 2a) for pipes, where the transitional area (16, 18) between that part of at least the one coupling half (flange) which extends mainly parallell (16,23) to the longitudinal axis (A) of the pipe and that part of at least the one coupling half which extends mainly perpendicular (18,22) to the longitudinal axis (A) of the pipe, comprises an elliptical area (16, 18), and where each coupling half (flange) has a surface (6, 7; 8, 10; 6, 10; 8, 7) forming a contact surface with the opposite coupling half (flange) (2, 2a), and where each single coupling half (2, 2a), independent of each other, is designed to contain joining devices (3, 4, 4a, 5, 5a),
c h a r a c t e r i z e d in that at least the one coupling half's (flange's) contact surface (6, 7) is designed in such a way that the surfaces (6, 7; 6a, 7a) between them form a conical slot with an opening towards the outside (7, 22; 10, 22) of the coupling.

2. Coupling according to claim 1,
c h a r a c t e r i z e d in that the opening angle (β) between the contact surfaces (6, 7; 6a, 7a; 9, 11; 6, 10; 6a, 10a) of the opposite flanges (2, 2a) in the conical slot is in the interval 0,2 to 3°.

3. Coupling according to any of the preceding claims,
c h a r a c t r i z e d in that the joining devices comprise bolts (3), washers (4, 4a) and nuts (5, 5a), where the prestressed length of the bolts (3) is at least 3 times the diameter of the bolts (3), and preferably 6 to 7 times the diameter of the bolts (3).

4. Coupling according to any of the preceding claims,
c h a r a c t e r i z e d in that at least one of the contact surfaces (6, 7; 6a, 7a) of at least one of the flanges (2, 2a) of the coupling, on its outer diameter (7)

and/or its inner diameter (6) comprises a protruding section (10, 11; 8, 9) formed as a wedge (7, 10, 11; 6, 8, 9) in front of the contact surface (6,7).

5. Coupling according to claim 4, c h a r a c t e r i z e d in that at least one of the contact surfaces (6,7) of at least one of the flanges (2, 2a) comprises two wedge-formed protruding sections (8, 9, 10, 11), where each of the conical planes for the wedge-shaped sections (8, 9; 10, 11) have an oppositely directed conicity.

6. Coupling according to any of the preceding claims, c h a r a c t e r i z e d in that at least one of the contact surfaces (6, 7; 6a, 7a) in at least one of the flanges (2, 2a) additionally comprises a groove (12) for a tightening washer/gasket.

7. Coupling according to claim 6, c h a r a c t e r i z e d in that the washer/gasket groove 12 comprise side surfaces (13, 14), each extending at an angle in the interval ± 10 to 20° to a central line which extends parallell to the longitudinal axis (A) of the flange.

8. Coupling according to claim 6 or 7, c h a r a c t e r i z e d in that at least one of the flanges comprises a bore (15) connecting a threaded joint on the outer surface to the bottom of the washer/gasket groove (12).

9. Coupling according to any of the preceding claims, c h a r a c t e r i z e d in that at least one of the flanges (2, 2a) comprises an elliptical intermediate section (16, 18) extending from the pipe section of the flange and being tangent to the rear flange plane, the ratio between its large axis and its small axis being in the interval 3:1 to 5:1, preferably 4:1.

10. Coupling according to any of the preceding claims, c h a r a c t e r i z e d in that at least one of the flange halves (2, 2a) further comprises a depressed groove (19) on its outer axis-symmetrical flange surface (7, 10, 22).

11. Process for connecting flanges, where at least one flange has a design according to any of the claims 1 - 10, c h a r a c t e r i z e d in that 50 to 100%, preferably 70 to 80%. of the load of the bolts (3) at the yield point is used to close the conical slot (6, 7; 8, 9; 10, 11) between the flange halves.

12. Use of the coupling according to claim 1 - 10 and/or process according to claim 11, for connecting pipe elements of risers.

13. Use of the coupling according to claim 1 - 10 and/or process according to claim 11, for connecting pipe elements in process industry.

14. Use of the coupling according to claim 1 - 10 and/or process according to claim 11, for connecting pipe elements in nuclear power plants.

15. Use of the coupling according to claim 1 - 10 and/or process according to claim 11, for connecting pipe elements within oil related industry.

16. Use of the coupling according to claim 1 - 10 and/or process according to claim 11, for stretch stays to floating platforms.

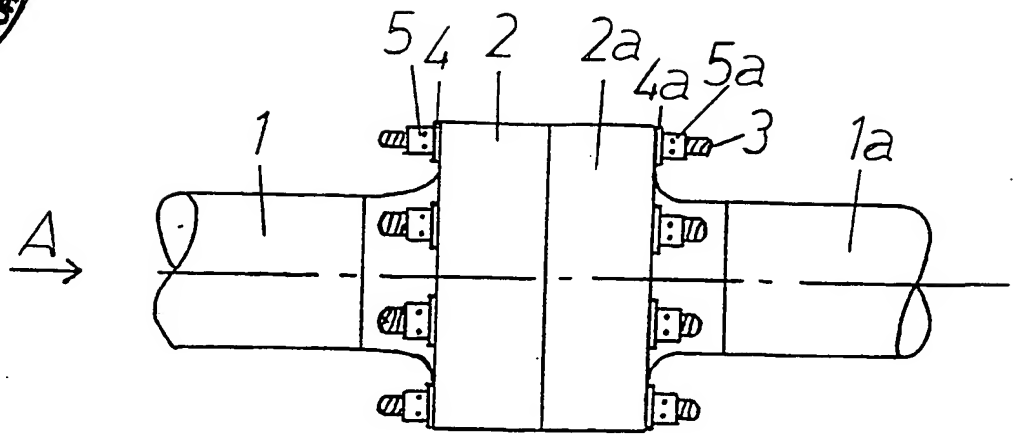

Fig.1

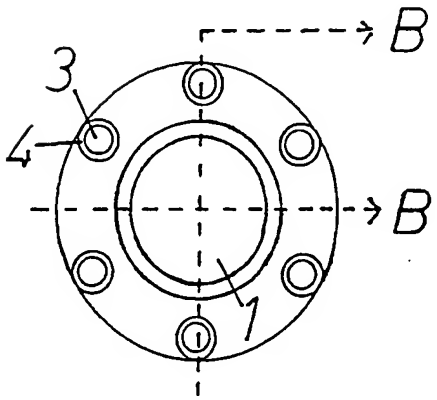

Fig.2

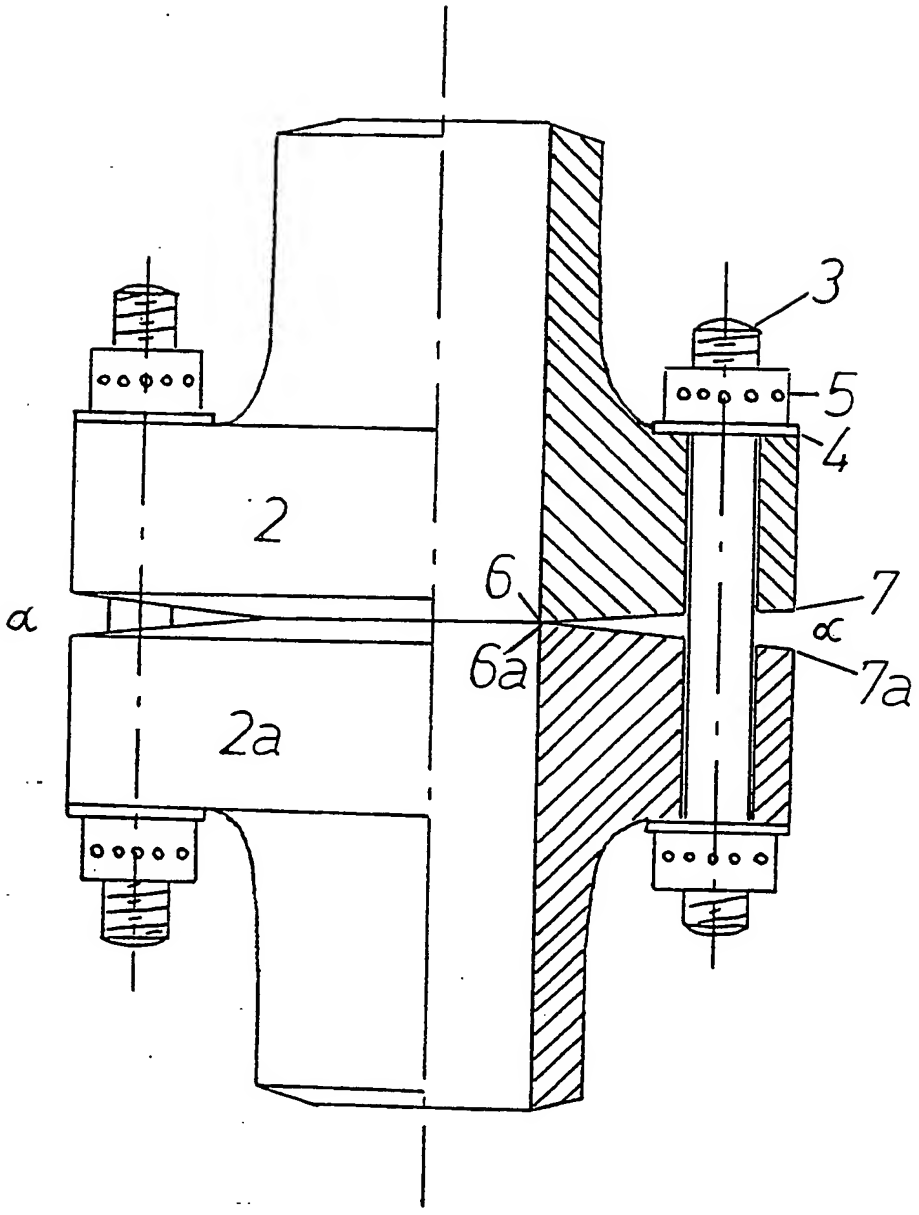

Fig.3

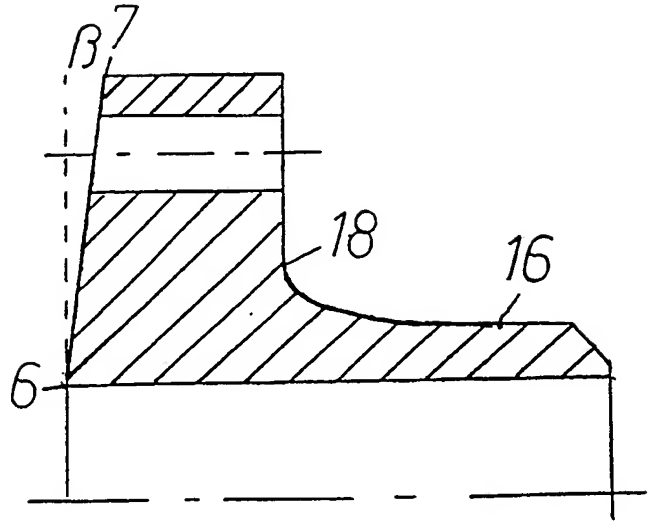

Fig.4

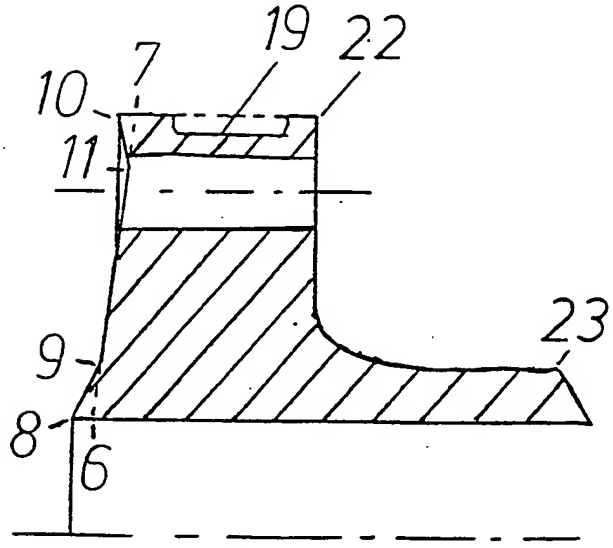

Fig.5

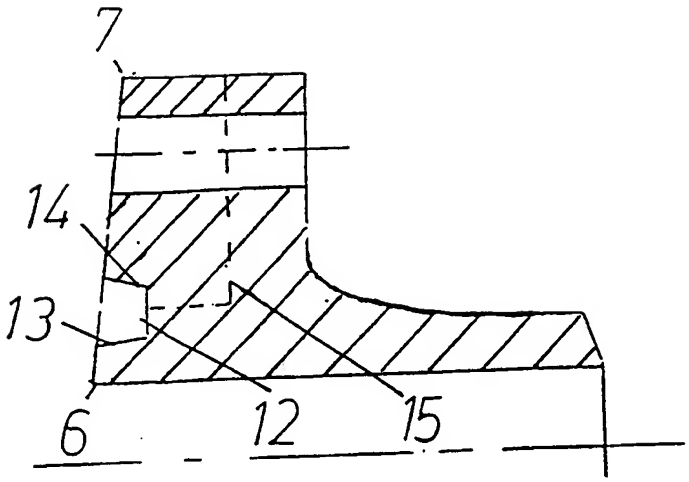

Fig.6

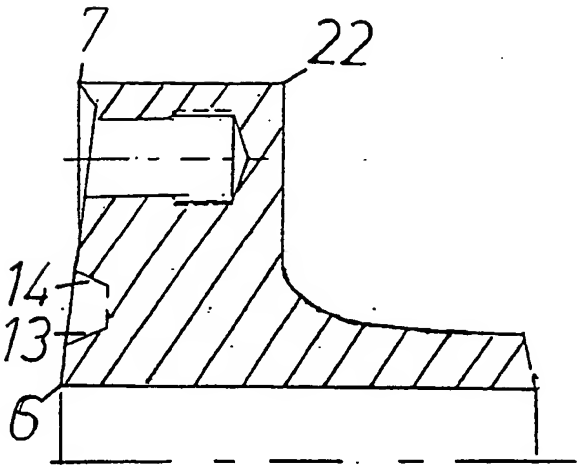

Fig.7

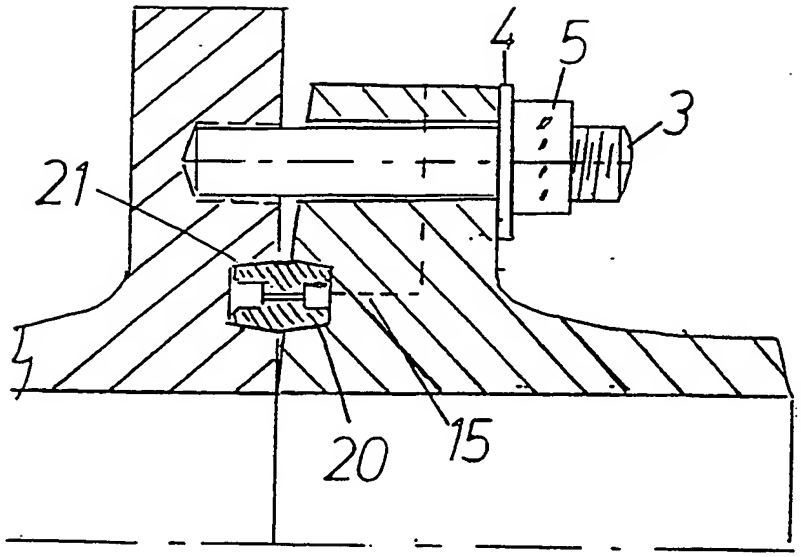

Fig.8

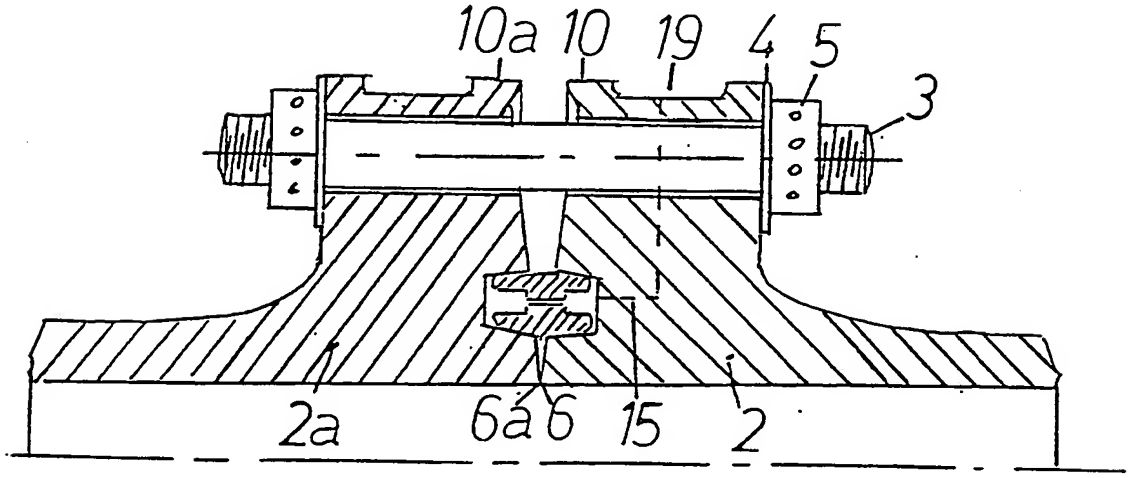

Fig.9

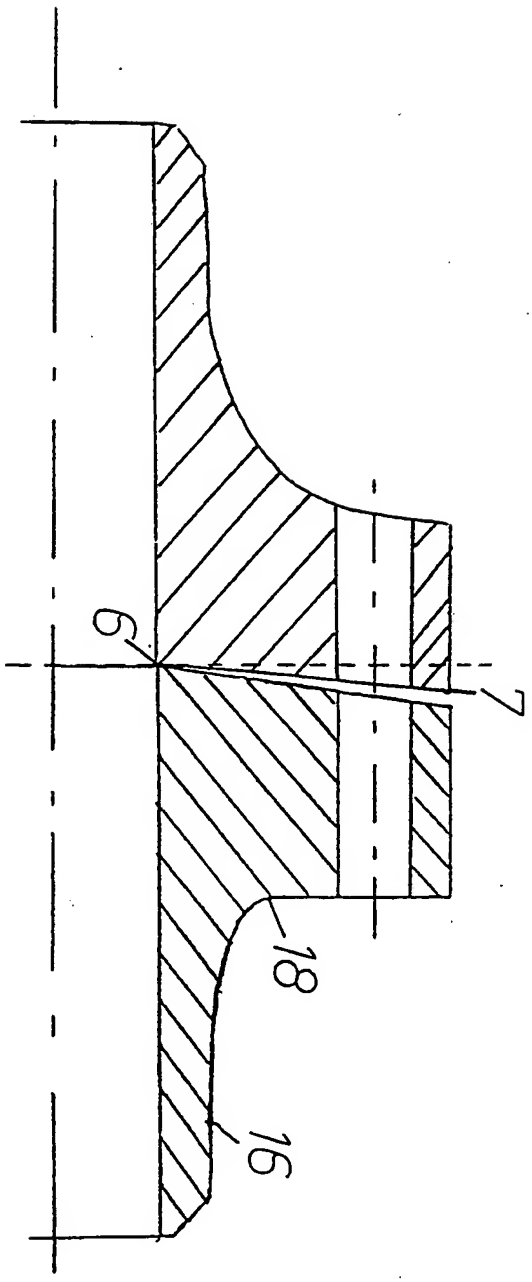

Fig.10

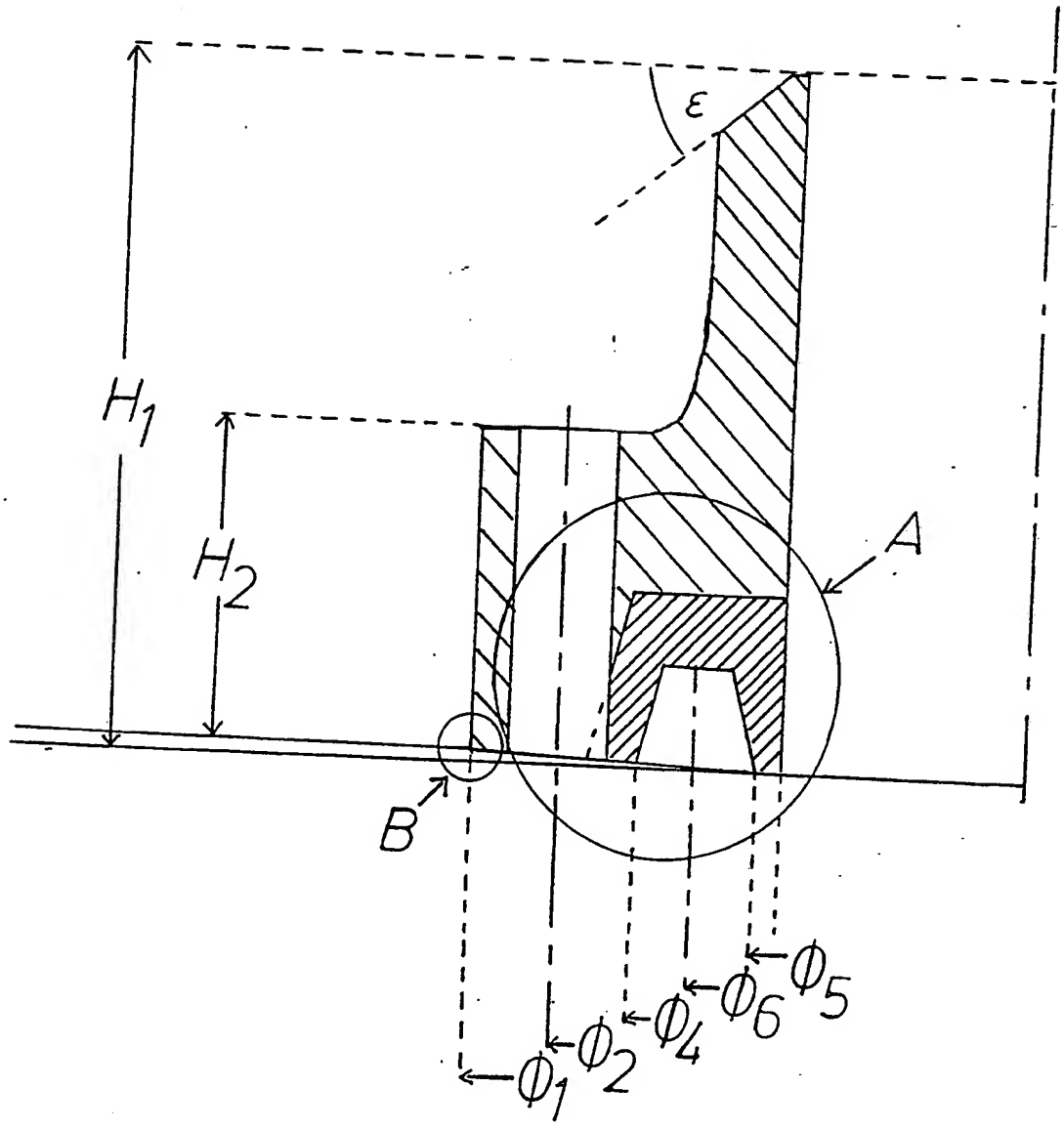

Fig. 11a

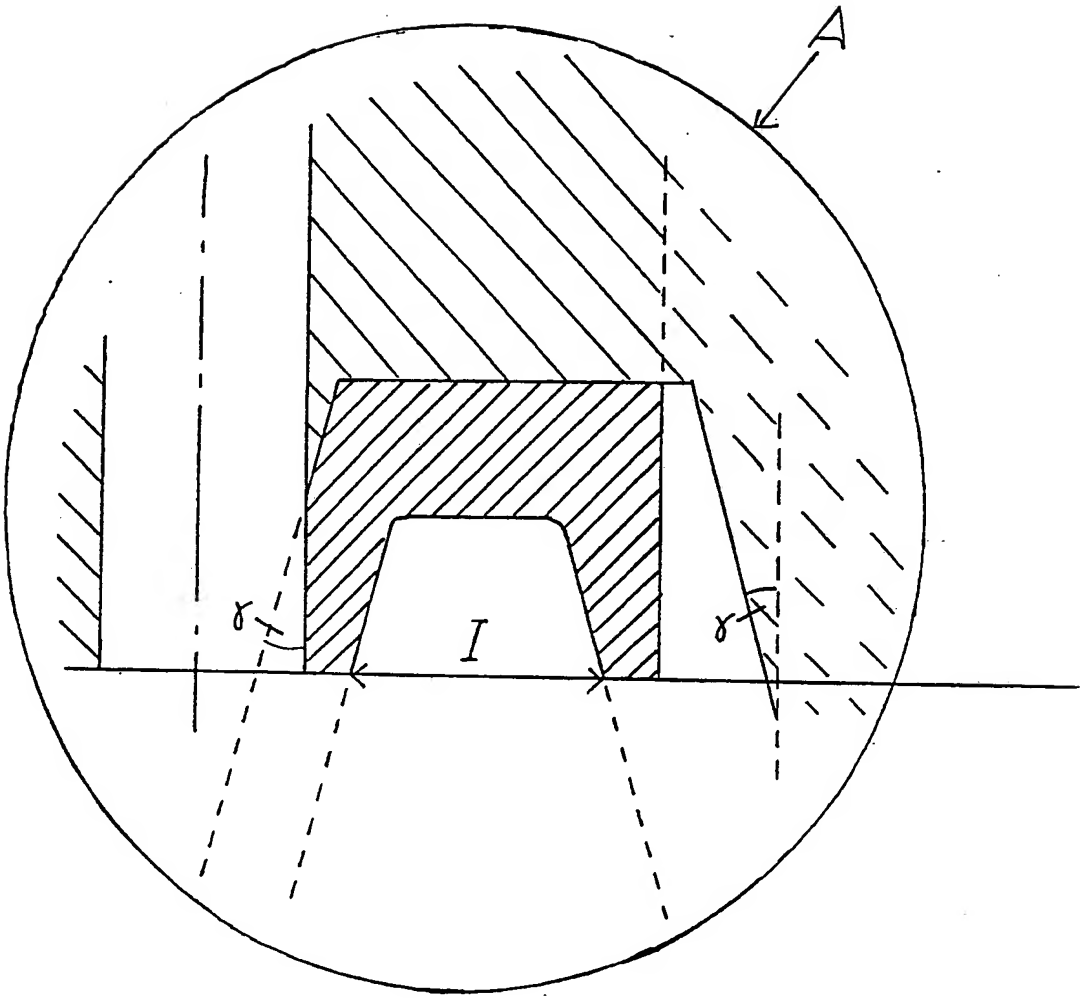

Fig.11b

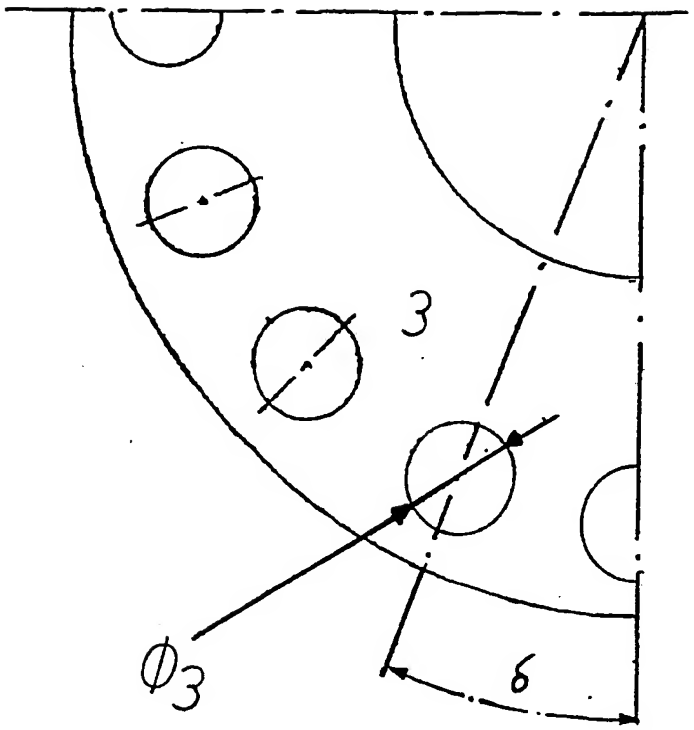

Fig.11c

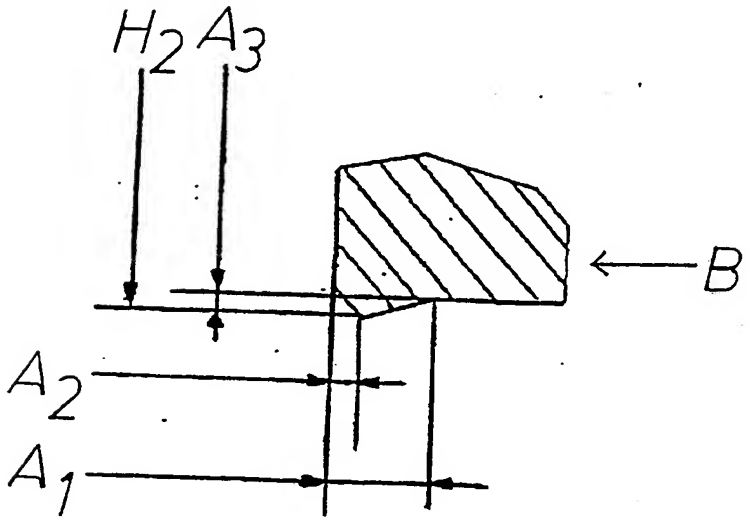

Fig.11d

A. CLASSIFICATION OF SUBJECT MATTER

IPC5: F16L 23/032
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC5: F16L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US, A, 2412487 (O.B. AMLEY ET AL), 10 December 1946 (10.12.46), column 2, line 31 - line 32, figure 2 --	1,11-16
Y	US, A, 3214201 (A.F. FONDA), 26 October 1965 (26.10.65), figures 1-11 --	1-3,11-16
Y	US, A, 4183562 (WATKINS ET AL), 15 January 1980 (15.01.80), figure 7 --	1,6,11-16
A	FR, A, 1563983 (A.V. BALITSKY ET AL), 2 April 1980 (02.04.80), figure 1 --	4,5

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
25 May 1993	'26 -05- 1993
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Axel Lindhult Telephone No. +46 8 782 25 00

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE, C2, 3103551 (KEMPCHEN & CO. GMBH), 11 Sept 1986 (11.09.86), figures 1,2 --	6,7
A	DE, A, 2239314 (SÖHLE, HARTMUT), 21 February 1974 (21.02.74), figures 1-4 --	8

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US-A- 2412487	10/12/46	NONE	
US-A- 3214201	26/10/65	NONE	
US-A- 4183562	15/01/80	DE-A,C- 2813119	12/10/78
		FR-A,B- 2385886	27/10/78
		GB-A- 1593347	15/07/81
		JP-C- 1302613	14/02/86
		JP-A- 53125201	01/11/78
FR-A- 1563983	02/04/80	NONE	
DE-C2- 3103551	11/09/86	NONE	
DE-A- 2239314	21/02/74	NONE	